

Atomic data for calculation of the intensities of Stark components of excited hydrogen atoms in fusion plasmas

Oleksandr Marchuk, Forschungszentrum Jülich (FZJ), Germany

Motional Stark effect (MSE) spectroscopy is a unique diagnostic tool for the measurements of magnetic field and its direction in fusion plasmas. The primary excitation channel for fast hydrogen atoms in injected neutral beams in the range of 25–1000 keV are collisions with protons and impurity ions (e.g., He²⁺ and heavier impurities). As a result of such excitation, at the particle density of $10^{13} - 10^{14} \text{ cm}^{-3}$, the line intensities of the Stark multiplets do not follow statistical expectations (i.e., the populations of fine-structure levels within the same principal quantum number n are not proportional to their statistical weights). Hence, any realistic modeling of MSE spectra has to include the relevant collisional atomic data. A general expression for the excitation cross sections in parabolic states within $n = 3$ for an arbitrary orientation between the direction of the motion-induced electric field and the proton-atom collisional axis will be presented. The calculations make use of the density matrix obtained using different calculation methods. The results can be applied to other collisional systems (e.g., He²⁺, Be⁴⁺, C⁶⁺, etc.). We point out that the asymmetry detected in the first classical cathode ray experiments between the red- and blue-shifted spectral components can be quantitatively studied using the proposed approach.